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SELF REGULATING HEATING CABLE

FOR

HEATING A PROPAGATION BENCH

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SELF REGULATING HEATING CABLE FOR HEATING A PROPAGATION BENCH

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INTRODUCTION

The merits of providing bottom heat or root zone heating for propagation and germination are well known. Root zone heating results in quicker and more uniform seedling emergence as well as faster and better root development in cuttings.

Various means have been used to supply this heat. Small diameter tubing carrying heated water has been used successfully as well as electric heating cables. Conventional single conductor electric heating cables have experienced a short working life due to cable burnout or control malfunctions.

A new use for an existing product was felt to show promise. This involved using an electric heat tracing cable to supply root zone heat. This tracing cable is unique in that it has a self-regulating heat output.

NOTE: The mention of manufacturers' trade names is for the purpose of specific equipment and description and does not indicate an endorsement of the equipment or descrimination of similar equipment by the author or Ontario Ministry of Agriculture and Food.

OBJECTIVE

To evaluate the application of a self-regulating heating cable to provide bottom heating in a plant propagation bench.

PRINCIPLE OF OPERATION

The heating cable used was Chemelex Auto-Trace Self-regulating Heater 6 ATV-CT. This heat tracing cable is presently used to provide freeze protection or process heating in residential, industrial or commercial buildings. By its design, this type of electrical heating cable is capable of providing varying amounts of heat, without external controls.

The heating cable tested consists of three bus wires encapsulated in a conductive core. The core is composed of a blend of cross-linked polymers, graphite, and stabilizers. This core material varies the cable heat output in response to the temperature changes of its surroundings. As any section of the cable temperature drops, heat output increases in that section and as the surrounding temperature increases, that part of the cable compensates by decreasing heat output. The self-regulating feature eliminates overheating and burnouts even where the cable crosses over itself. The cable in simple terms behaves like an infinite number of self-limiting resistors connected in parallel, See Figure 1. This cable has the capability of providing constant surface temperature throughout its length even though different sections of the cable may be providing different wattage outputs to meet varying demands for heat along the cable length.

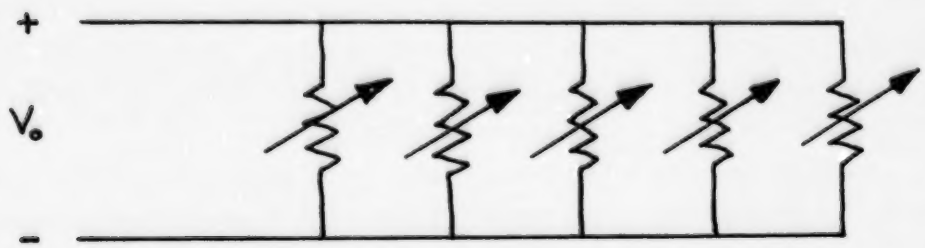

FIGURE 1. SELF-LIMITING PARALLEL ELEMENT

The bus wires in the heating cable are electrically connected only through the conductive core of the cable. One end of the cable is energized by the electrical power supply while the other end is simply terminated with a protective cap. This allows for easy field installation since the heating cable can be cut to any desired length, with no need to return to the starting point. The maximum length of individual cables is dependent on the type of cable and the supply voltage.

A number of additional coverings are added over the conductive core material in order to provide grounding capability as well as mechanical and weather protection. Figure #2 shows the construction of the test cable in detail.

TEST SYSTEM

A propagation bench in the greenhouse at Ridgetown College was prepared for utilization of this self-regulating heating cable. The raised wooden benches are used to hold the growing medium for plant propagation. The test bench was 1m wide by 9m long. The cable was spaced on 250mm centres. The cable as configured for testing produced 26 watts/m when powered from a 120V A.C. supply source. This provided a watt density of 104 watts/m^2.

The bottom of the test bench was covered with a 25mm thick sheet of expanded polystyrene insulation to minimize downward heat flow. Next a sand layer 30mm deep was placed on the insulation. This sand serves a dual function. First, it allows for the easy placement of the heating cable, which is laid out then pushed down to a depth of approximately 15mm. Secondly, the sand aids in the dispersion of the heat through the bed area. On top of the sand artificial growing medium, namely perlite, was added. In the area where flats or pots would be used the growing medium was 50mm deep. Where cuttings were rooted, the growing mix was 120mm deep.

An unheated "control" bench had 120mm of growing mix placed directly in the bench. Figure #3 shows the bench construction and the cable layout.

Both the heated bench and the unheated control bench were kept moist with an aerial misting system. Misting is essential to keep the seeded flats, pots, and cuttings moist to ensure proper germination and root development.

Temperatures were recorded at 10 different locations along the benches, then averaged for Table #1. Care was taken so that growing mix temperatures were not taken directly above the heating cable. Temperatures were measured at the mid-depth of the growing mix using a hand held digital thermometer. Both the test and control benches were located in the same greenhouse which was maintained at approximately 21^0C.

RESULTS

The seeds germinated sooner on the heated bench than on the control bench. Root development on cuttings in the heated bench was faster and better than in the control bench.

Table #1 summarizes the growing media temperatures, ambient air temperatures, greenhouse air temperatures and electrical energy consumption. The growing media temperatures were significantly different in the heated and unheated benches. Soil temperatures in the control bench were approximately 13^0C to 16^0C. The heated bench on the other hand maintained soil temperatures in the 29^0C to 32^0C range. This soil temperature is ideal for the type of propagation carried out at the college.

Throughout the two month test period, the average daily energy used by the heating cable in the $9m^2$ bench was 16.7kWh. This works out to roughly $1.9kWh/m^2/day$. With electricity costs at $0.05/kWh this translates to $0.095/m^2/day$.

SUMMARY

The seedlings and cuttings responded as expected with bottom heat, with faster and better root development. This self-regulating heating cable performed well, maintaining the germination/propagation medium at the desired root zone temperature of approximately 30°C. The cost of operating this cable was just under $0.10 per square metre of bench per day.

Capital costs were not included in this report. The Chemelex 6 ATV-CT Auto-Trace Self-regulating Heater is no longer available but has been replaced with a two conductor cable with the same heat output capacity. External coverings were also changed thereby resulting in a lower cost heating cable. The newer heating cables are available with different heat output capacities.

This type of self-regulating heating cable offers a greenhouse grower a very quick and reliable heating mechanism which can be easily installed.

ACKNOWLEDGEMENTS

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Mr. John Turner, Raychem Canada Ltd. - Mississauga, for supplying the self-regulating heating cable for the test at no charge.

Mr. Harry Wyma, Ridgetown College, for installing the cable in the propagation bench and assisting with data collection.

Mr. Peter Ziebart, Ontario Hydro - London, for supplying the kilowatthour meter used to measure electrical energy consumption.

REFERENCES

Stewart, S.M., R.G. Winfield, Soil Heating For Tomato Plant Production From Seed In Open Plots, C.S.A.E. Paper No. 72-503, June 1972.

SOIL HEATING DATA SUMMARY

TABLE #1

DATE	TIME	AMBIENT AIR TEMP.	G.HOUSE AIR TEMP.	SOIL TEMP. CONTROL	SOIL TEMP. HEAT CABLE	AV. ELECT. USED kWh/d
Mar.04	11:00	2°C	22°C	15.5°C	31.1°C	
" .07	14:00	-13	23	15.0	29.7	17
" .11	11:30	4	21	14.5	30.0	16.5
" .13	13:00	3	21	13.1	29.3	17
" .14	13:20	5	23	15.9	31.8	17
" .19	11:40	9	20	17.2	32.0	16.6
" .26	12:50	10	22	17.7	29.6	16.7
Apr.01	11:30	16	26	16.8	30.2	16.2
" .10	13:00	3	22	15.3	29.7	16.7
" .11	12:30	8	20	15.7	30.4	17
" .14	13:00	10				13.3

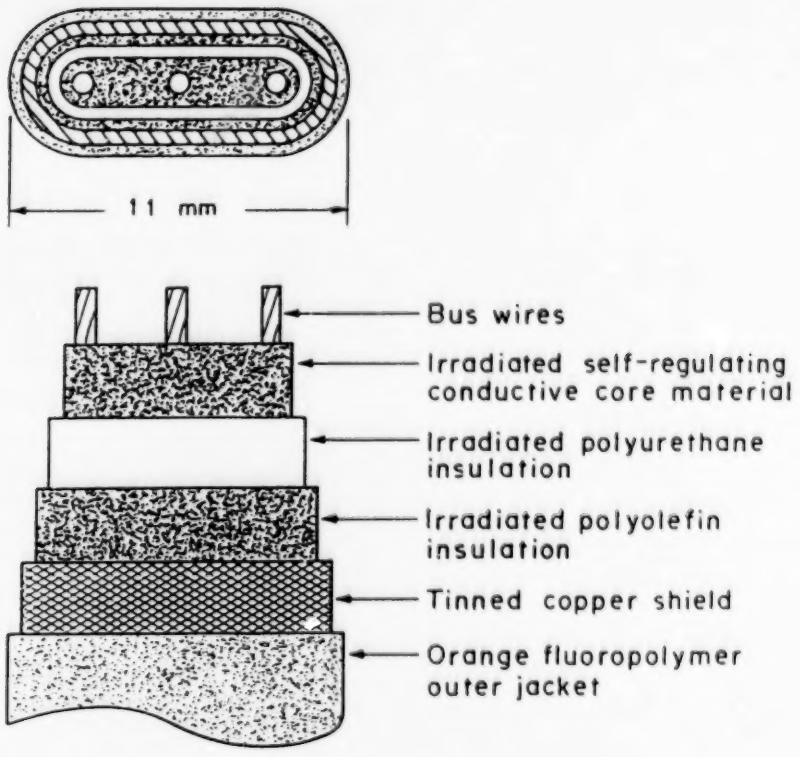
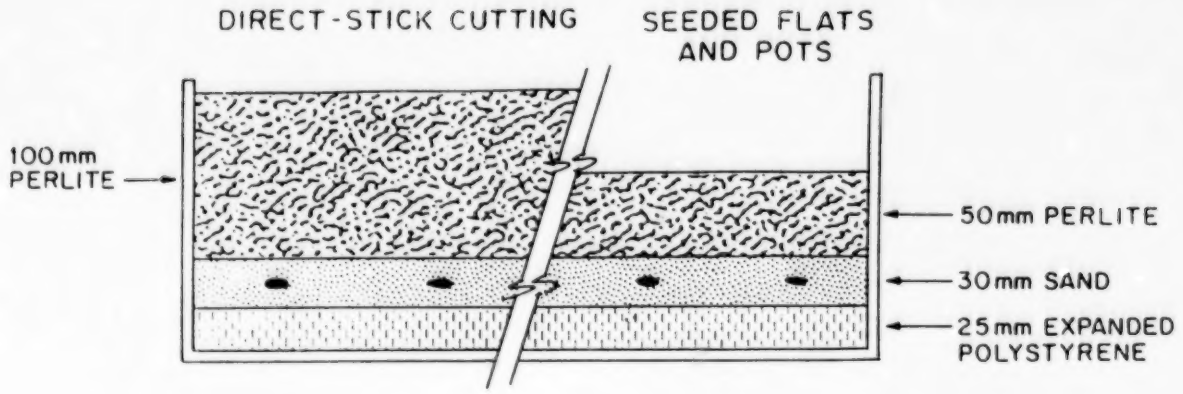


FIGURE 2 - CONSTRUCTION OF CHEMELEX 6ATV-CT



CROSS-SECTION THROUGH BENCH

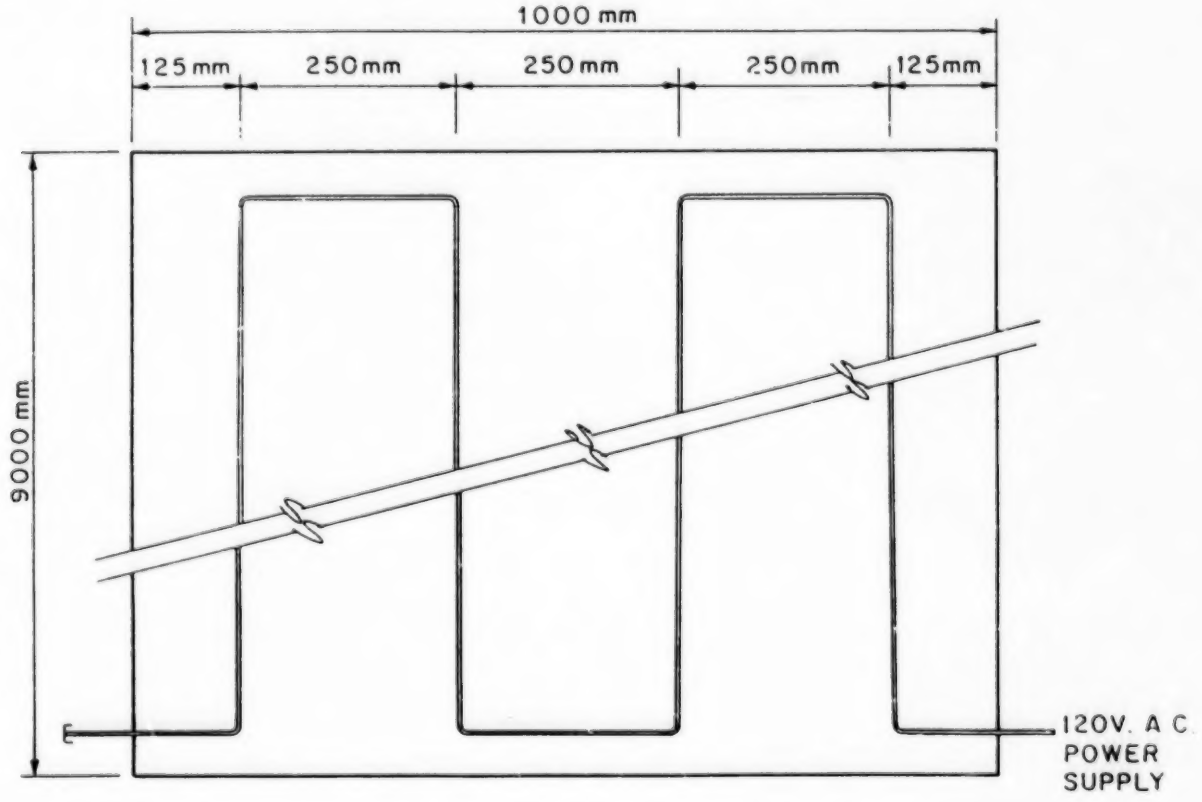


FIGURE 3 – CABLE LAYOUT IN BENCH